ENERGY FACILITY SITE EVALUATION COUNCIL

In the Matter of Application No. 96-1, OLYMPIC PIPE LINE COMPANY CROSS CASCADE PIPELINE PROJECT.	**NO.** **PREFILED TESTIMONY OF :** **GARY A. PASCOE, PH.D** **ISSUE: ENVIRONMENTAL TOXICOLOGY** **SPONSOR: COUNSEL FOR THE ENVIRONMENT**

Q. Please state your name and employment position.

A. Gary A. Pascoe
Natural Resource Consultants, Inc.
4055 21st Avenue West, Suite 100
Seattle, WA 98199

Q. What is your educational and employment background?

A. Ph.D. Toxicology and Comparative Pharmacology, University of California, San Francisco, 1983.
B.A. Biology, University of California, San Diego, 1976.

Natural Resource Consultants, Inc., Seattle, WA, 1997-present.

EA Engineering, Science, and Technology, Inc., Bellevue, WA, Senior Scientist, 1995-present.

Environmental Toxicology International, Inc., Seattle, WA, Technical Director, 1989-1995.

Tetra Tech, Inc., Bellevue, WA, Toxicologist, 1987-1989.

Department of Medicinal Chemistry, University of Washington, Seattle, WA, Research Associate, 1986-1987.

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Environmental Health Sciences Center, Oregon State University, Corvallis, OR, Research Associate, 1983-1986.

Q. Please explain your experience in assessing resource damages from proposed land use activities or project developments.

A. I have assessed previous impacts to natural resources and potential future risks for a large number of projects across the US. The following are samples of these projects:

Provided technical assistance and review of fish and benthic invertebrate toxicity studies, and analyses of the recovery of impacted sediments for the Commencement Bay Natural Resource Damage Assessment.

Performed a Remedial Investigation/Feasibility Study for mercury and ordnance-contaminated sediments of a Navy site at a Puget Sound bay. Managed or conducted sediment bioassays and sedimentology, sediment transport, and source identification studies to determine an appropriate plan to remediate the sediment resources of the bay. Integrated Washington Model Toxics Control Act Sediment Management Standards and CERCLA requirements to assess aquatic risks.

Evaluated remedial options to minimize ecological impacts of contaminated sediments during construction of an aquarium at an estuarine National Park Service site in Charleston, SC.

Performed a site-specific ecological risk assessment for a metals-contaminated wetland in Montana that was planned to be turned into a recreational area. Coordinated field sampling efforts of U.S. EPA, U.S. FWS, university researchers, and local agency personnel, to document impacts to wetland ecology and to predict risks of future impacts to wetland ecology, groundwater, and human exposures from the presence of contaminated sediment.

Performed an assessment of ecological risks due to DDT, PCBs, and heavy metal contamination in sediments and biota of the Southern California Bight, under the Clean Water Act permit application for effluent discharges.

Provided technical oversight of field sampling and data compilation of mercury contamination of sediments and biota of freshwater ponds in northern Mississippi, to support a permit application to burn hazardous waste fuels.

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Evaluated ecological risks of an abandoned industrial property for the Washington National Guard, prior to its transfer to a municipal park under Model Toxics Control Act. Terrestrial and marine habitats were evaluated for risks from PCBs and metals.

Reviewed the human health and water resource impacts of asphalt hot mix plants in preparation for a county board hearing on a permit in Washington.

Reviewed numerous human health and ecological risk assessments under CERCLA and RCRA for U.S. EPA at military bases, landfills, and industrial plants.

Q. Please explain your experience in assessing natural resource damages caused by spills of crude oil or refined petroleum products.

A. The following projects document my experience in assessing impacts and risks to natural resources caused by the presence of petroleum products.

Provided senior technical oversight and review of ecological and human health risk assessments as part of the transfer of property at the Naval Arctic Research Laboratory in Barrow, AK. Cleanup levels for petroleum constituents and TPH measurements were developed to mitigate impacted groundwater, surface water, and soils; to protect terrestrial and aquatic ecological receptors; and to protect human health of local residents and during recreational activities.

Designed a risk-based model for developing remediation goals for TPH in soil and groundwater, for a Port of Seattle industrial redevelopment project. The model focused on protecting marine organisms exposed to groundwater discharges from multiple industrial properties.

Assessed ecological and human health risks due to petroleum and petroleum constituents at an abandoned oil refinery in Montana as part of remediation and cleanup of the site.

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Q. In general, how did you prepare the testimony you are giving to the Council?

A. I prepared the testimony by reading portions of the Application for Site Certification submitted by the Olympic Pipeline Company for the Cross Cascade Pipeline Project, by identifying scientific deficiencies in the Application, by reviewing scientific and technical information on the potential for environmental impacts due to petroleum product spills, and by synthesizing a professional opinion on the presentation of the potential for environmental impacts in the Application.

Q. What is the subject of your testimony to the Council?

A. The subject is the risks to aquatic resources, including groundwater, that could result from potential spills of petroleum products from the proposed pipeline. In the attached report, Risks to Aquatic Resources, Exh. GAP-1, I provide a framework for understanding the fate and effects of a refined oil spill, and indicate that adequate information exists to describe such fates and effects through the Ecological Risk Assessment process. NRC performed simple calculations as examples of estimated concentrations of refined oil product in the aquatic environment as a means to illustrate the nature of acute and chronic risks to aquatic resources. The report also presents information from case studies on previous pipeline spills of refined product that provide reference for potential effects from spills from the proposed pipeline. Finally, I offer a brief critique of the spill scenarios presented by Olympic in the Product Spill Analysis.

Q. What are the major conclusions you drew from your analysis regarding the potential risks to aquatic resources along the pipeline route?

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A. My major conclusions are that the Application for the pipeline is deficient in its evaluation of the potential risks to ecological resources along the route of the pipeline. The Application should have provided a thorough analysis of the potential for various spill scenarios to cause impacts to the aquatic resources along the pipeline. Scientific information and methodology exist that can be used to estimate risks based on exposure modeling and toxicology of the petroleum products and constituent chemicals. An analysis of risks to resources along the pipeline route would provide a means of comparing the relative potential impacts of the proposed pipeline, alternative pipeline routes, and alternative modes of transporting refined petroleum product to eastern Washington. Our findings in the case studies that spills into creeks with flow rates similar to many creeks along the pipeline route resulted in documented impacts to aquatic resources support the conclusion that aquatic ecological risks should be more thoroughly evaluated

Q. What are the primary constituents of refined petroleum products that pose risks to aquatic resources in the event of a spill from the pipeline?

A. The proposed Cross Cascade Pipeline will transport gasoline, diesel and jet fuel, which all contain petroleum hydrocarbons as well as other chemical compounds. The most well studied of the petroleum hydrocarbons are benzene, toluene, ethylbenzene, and three forms of xylene, (collectively are known as BTEX), which are the major toxic constituents of gasoline; hexane, another major toxic constituent found in gasoline; and the polycyclic aromatic hydrocarbons, known as PAHs, which are larger compounds found primarily in kerosene, diesel fuels, and heavy fuel oils. Ecological risks tend to be concerned with a variety of toxic effects from BTEX

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and PAHs. In general, human health risks from petroleum exposure tend to be concerned with carcinogenicity that may be caused by benzene and the carcinogenic PAHs, and to a lesser extent the non-cancer toxicities of hexane and pyrene.

Q. How do these compounds affect aquatic organisms?

A. The compounds can affect the organisms through acute toxicity from sudden exposure to the chemical, chronic toxicity from prolonged exposure, and persistence due to the length of time the chemical stays in the environment in an undegraded state. Refined petroleum products can also create some mechanical injury (coating or smothering organisms) but not nearly to the extent that crude oils do.

Acute toxicity is typically reported as the concentration of chemical that kills 50 percent of the test organisms, and is called the LC50 (i.e., lethal concentration-50%). Most LC50 values for petroleum products are based on the water soluble fraction of the product. Acute toxicity tests tell us the amount of chemical, or product, that kills the organisms in a short period of time, typically in 24 hours or less, depending on the species used in the test. The values for acute toxicity of petroleum products range over orders of magnitude for different aquatic species. As summarized in API (1994), LC50 values for aquatic invertebrates exposed to petroleum products in water range from 3.36 mg/L for diesel to 20 mg/L for gasoline. For fish, the LC50 concentration for diesel is 3.5 mg/L. Several studies summarized in API (1992, 1995) provide an estimate that 50 mg/L of refined petroleum product can be considered as representative of acute toxicity to rainbow trout. This is the value we have used in the analysis.

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Chronic impacts are due to exposures of aquatic organisms to lower amounts of product over a longer period of time, i.e., the impacts due to small amounts of refined product entering a stream from a chronic slow release. This type of exposure is of concern for its effects on growth, reproduction, swimming ability, avoidance of food and spawning areas, and a host of other physiological and health parameters. These effects do not kill the fish, but instead make it unable to avoid predators or to properly reproduce. This effectively removes the fish from the environment with an ecological impact similar to an acute exposure. Chronic toxicity typically is determined from tests performed within 96 hours of exposure, but may go as high as 7 to 14 days, depending on the specific type of organism used in the test.

Chronic toxicity values are substantially lower than the acute values presented above (i.e., LC50 values) and are indicative of the greater sensitivity of aquatic organisms to prolonged exposures to low concentrations of chemicals. Research has been reported by U.S. Fish and Wildlife Service that provides an estimate of chronic toxicity to trout (Woodward and Riley 1983; Woodward et al 1983, 1987), which is typically used in toxicity tests as an indicator of the impacts of chemicals in freshwater systems. Results of the chronic toxicity testing showed that the threshold for toxicity of the refined petroleum product to cutthroat trout ranged from 24 ug/L to 39 ug/L. (A ug is 1/1000th of a mg.)

Petroleum products and their constituent chemicals can also pose health risks to aquatic organisms in freshwater sediment. Sediment organisms of concern have primarily been macroinvertebrates, such as insects, crustaceans, and worms that serve as food sources to fish. Macroinvertebrates can be very sensitive to chemical contamination; for example, the LC50

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values compiled in API (1994) show invertebrates as being up to 10 times more sensitive to petroleum products than are fish.

Persistence of refined petroleum products and constituent hydrocarbons varies for different hydrocarbons and under different environmental conditions. In general, the smaller aromatic chemicals, such as BTEX, tend to volatilize following spills, such that half-lives in the environment may be on the order of hours to days (API 1994). However, their volatility is dependent on the ambient temperature and wind, and will be much less following a spill during cold temperatures. The acute toxic effects can be exerted within a few hours of a spill, before much of the BTEX has evaporated.

PAHs are more persistent and have half-lives estimated in terms of months (API 1994). Because of the relatively greater persistence of PAHs and other less volatile constituents, their chronic toxicity to aquatic organisms is of greater concern. PAHs have been shown to bioaccumulate in tissue of fish and other aquatic organisms (API 1994). For example, naphthalene was detected in the trout that were used to study the chronic toxicity of refined petroleum product to freshwater fish (Woodward et al., 1993).

Q. What type of information should be used to address risks to aquatic resources in surface waters along the pipeline route?

A. Spill scenarios should be developed that use calculations of estimated concentrations of refined petroleum products in streams using a range of spill volumes and stream flows.

Q. Has NRC developed such scenarios?

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A. Yes, we developed scenarios based on simple calculations of estimated concentrations of refined petroleum products in streams from different spill volumes and stream flows. The scenarios were developed for acute and chronic exposures, and demonstrate that concentrations of refined product that can be acutely toxic to salmon or sublethally (chronic) toxic to salmonids can occur during a spill to a wide variety of streams and rivers. See Exh. GAP-1, pp. 7-10.

Q. Do these scenarios provide sufficient information to adequately characterize the risks to aquatic resources posed by spills from the proposed Cross Cascade Pipeline?

A. No. The scenarios in Exh. GAP-1 are based upon simplifying assumptions and are intended only as examples of estimates of potential impacts to aquatic resources. The Application should include more detailed information and analysis. What our scenarios do is show that the pipeline poses real risks to aquatic resources; that information and analytic methods are readily available to Olympic, yet Olympic failed to provide such an analysis in its Application.

Q. Is the information necessary to conduct a more detailed analysis readily available?

A. Yes. Guidance on ecological risk assessment methodology has been developed by U.S. EPA for use at Superfund sites. Models are available to estimate the volatility, dispersion, mixing, microbial degradation, and bioavailability of refined oil product components, such as BTEX, and possibly whole oil product. In particular, the physical and chemical information used for modeling environmental fate and transport can be obtained from the industrial whole effluent toxicity (WET) monitoring programs, using either oil and grease or total petroleum hydrocarbons

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(TPH) as model mixtures, or from the TPH Criteria Working Group (TPHCWG 1997). Various studies are on-going that are developing and using this information, especially from the Brownfields Initiative that U.S. EPA is partially funding to assess the ecological risks of TPH at industrial sites in Washington. An electronic library search or a search of the toxicology and criteria sources mentioned above can provide a variety of cleanup levels for TPH and BTEX in surface water and groundwater. Soil cleanup levels for petroleum constituents and TPH are under development within Ecology. The Risk-Based Corrective Action (RBCA) framework, developed by ASTM (1995) for evaluating risks from spills of petroleum products also provides a model that could be used to assess aquatic receptor and groundwater risks along the proposed pipeline route.

Q. How did you estimate the risks to aquatic resources in surface water from a spill of refined petroleum product?

A. Using some simple assumptions, it is possible to estimate the concentrations of refined oil product in receiving waters from a range of spill sizes. In Table 1, Exh. GAP-1, Tab A, we have used a variety of spill sizes for trucks, pipeline, and barges, along with a range of stream flow rates, to estimate petroleum product concentrations over periods of time from 30 minutes to 96 hours after the spill. In making the calculations, we have assumed a direct input of petroleum product into the river, with complete mixing with no loss from volatilization or degradation, no binding of product with sediment materials, and an even distribution of the concentration in the water column of the river. The latter assumption of an even distribution in the water is unlikely, especially if the release into the river occurs over a very short period of time. These assumptions

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are considered conservative in that they will overestimate concentrations. However, they are presented to demonstrate a worst case scenario of a wintertime spill into a snow covered area and allow a simplified approach to estimating concentrations of product in the water. We compared the estimated concentrations with 50 mg/l, the acute toxicity concentration for rainbow trout. (API 1992, 1995).

Q. What were the results of the risk estimate?

A. As shown in Table 1, Exh. GAP-1, Tab A, the simple exposure modeling predicts that even moderate spill (2600 gals) volumes at low and moderate stream flow rates (1-350 cfs) will result in exceedance of the acute toxicity value and would present a risk to fish survival in the stream In contrast, the scenario for all spills into the high stream flow of the Columbia River results in minimal risks for acute toxicity. Assuming that a 260,000 gallon release occurs as a major release from a barge on the Columbia River, the estimated concentrations of product in the river water would be below the 50 ppm acute toxicity threshold after the equivalent of 30 minutes of river volume flows past the spill. The comparison with the other spill scenarios in Table 1 suggests that barging on the Columbia River would present a much lower acute risk to fish than an average pipeline spill (26,000 gals) on the Yakima River (with a flow rate of 1600-8500 cfs). Such comparisons between spill scenarios for barging on the Columbia River and pipeline spills into the Yakima and other rivers should be included in the Application.

Q. Did you make a similar analysis for chronic spills?

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A. Yes. Chronic spills are defined as low volume spills that last for an extended period of time. Chronic spills are not expected from either trucks or barges, which would more likely release product over a short period of time. The analysis, therefore, addresses only chronic spills from the pipeline. The results are shown in Table 2, Exh. GAP-1, Tab B.

The estimates of product concentrations in streams and rivers are the result of a simple calculation, assuming that a certain amount of product enters the stream per second, and is diluted into the stream's flow. Therefore, a continuous concentration occurs. This concentration can be considered a maximum concentration, as the percent entering the stream may be only a fraction of the amount available, and the many changes that could occur, such as volatility, are not addressed. The spill scenarios assume complete mixing of product in water and maintenance of the estimated concentration as long as the leak continued. Many other factors would likely result in concentrations lower than the predicted concentrations, such as volatility, adsorption to sediments, and to a lesser degree, chemical degradation. Under conditions of warm weather with winds, volatility could result in significant decreases in concentrations of the smaller petroleum compounds, such as the BTEX compounds. However, under winter conditions with low temperatures, and with low winds, minimal volatilization would be expected.

Q. How do the spill amounts considered in Table 2 relate to potential chronic spills from the pipeline?

A. All of them are at or below the volumes that can be automatically detected by the pipeline system. According to the Application, the SCADA system cannot detect a leak of less than 1% of pipeline flow rate. At the initial flow rate of 2.5 million gallons per day, a leak rate of 1%

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would produce 25,000 gallons per day. A leak of this size could quickly cause major impacts. Even assuming a leak detection threshold of 0.1% of pipeline flow, the resulting leak would be 2500 gallons per day.

Q. How did you determine the risks to aquatic resources from a chronic spill?

A. An estimation of chronic risks to aquatic receptors is based on relating the predicted concentrations under the chronic spill scenarios to the concentration that would result in sublethal effects. As mentioned above, studies performed by U.S. Fish and Wildlife Service estimated a chronic toxicity value for refined product effects to cutthroat trout at 24 to 39 ug/L. For the present chronic risk estimation, we assumed that the response of the trout in the study is a sensitive representative of salmonid species, and used a value of 25 ug/L (0.025 mg/L).

Results of the chronic risk estimates are shown in Table 2, Exh. GAP-1, Tab B, with bold values indicating predicted petroleum product concentrations that would exceed the chronic toxicity value. The predicted concentrations are also compared with the acute threshold of 50 milligrams per liter described above. Table 2 shows that for slower chronic spills, at much lesser volumes than estimated for acute spills, chronic risks can be predicted for all sizes of streams depending on the spill rate, including a large spill on the Columbia River.

As mentioned in the previous section, chronic spills may also affect macroinvertebrates that inhabit the water column and sediment of streams and rivers, many of which may be more sensitive than the trout. Altered macroinvertebrate populations or availability would directly impact salmon by removing food sources. Further impact studies should include food source macroinvertebrates to determine which level of chronic exposures would result in levels harmful

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to fish food sources.

Q. Have you compared your analyses of the potential impacts to aquatic resources from acute and chronic spills to any case studies?

A. Yes, we gathered information for comparative purposes from three case studies of spills of refined petroleum products into streams. Des Moines Creek, near SeaTac International Airport, is an example of two sudden spills into a small stream; Camas Creek in Montana is an example of a chronic spill into a small stream; and Reedy River in South Carolina is an example of a large spill into a river. In all these cases, based upon the amount of product spilled and the average stream flows, our models predicted toxicity to fish. The prediction was confirmed by field investigations which documented fish kills. Exh. GAP-1, pp. 11-14.

Q. Did you also do an analysis of the risk to groundwater from a spill from the pipeline?

A. Yes. We predicted refined product concentrations from a spill and estimated health risks for differing aquifers based upon recharge rates, water usage, soil and strata types, and groundwater flow rates. The groundwater risk model uses data from a USGS study for east King County that includes miles 14 to 41 of the pipeline. (Turney et al 1995). The goal of the model was to determine if concentrations of spilled products under reasonably realistic scenarios would exceed established health-based water quality criteria. As with the previous simple models, the groundwater risk model does not address degradation of contaminants and assumes that the leaks occur over an area sufficient to produce a uniform concentration of product in the groundwater.

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With these assumptions, the predicted concentrations are a conservative overestimation of potential concentrations.

Spills to groundwater would function as chronic releases. The model is based on small releases of product, below the SCADA System detection limit. Unlike the Product Spill Analysis of the Application, our groundwater risk model assumes that the spills occur over 14 and 100 days. These times were selected to represent the estimated times for detection of contaminated groundwater in wells or in streams that would result in pipeline shutdown and inspection for leaks on a 2 week or quarterly (i.e., 100 days) schedule. As with the acute risk modeling, the groundwater risk model does not attempt to produce a concentration gradient over time, but assumes that the amount of released product is incorporated into the groundwater in an instantaneous and continuous fashion for the time period chosen.

Results of the estimation of petroleum product concentrations in groundwater from pipeline spills are shown in Table 3, Exh. GAP-1, Tab C. Concentration in groundwater is estimated by dividing the product amount by the volume of water in the groundwater and the amount entering the system as recharge. Data on the amount of recharge and strata information were from USGS. The risk model uses two health-based criteria in Table 3: (1) 0.4 milligram per liter, which accounts for the BTEX compounds and aliphatic compounds in gasoline that have criteria of less than 1 milligram per liter, and (2) 5 micrograms per liter, which is the criterion for benzene. Exceedances of the criteria by modeled groundwater concentrations are shown in bold in Table 3. The results show a significant potential for ground water contamination from a pipeline leak.

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Q. Do you have similar concerns about the groundwater in eastern Washington?

A. Yes, there are also significant groundwater concerns along the eastern Washington portions of the proposed pipeline route. Not only are there more extensive groundwater withdrawals for irrigation, which could be impacted by petroleum contamination, but different conditions in eastern Washington such as less rainfall, differing rock structure, and the presence of fractured rock could allow faster penetration of product to groundwater, and to deeper aquifers. These characteristics could allow differing amounts of product to accumulate in strata above the groundwater compared to western Washington, resulting in long-term impacts to groundwater resources.

Q. Have you reviewed Olympic's spill scenarios in the Product Spill Analysis?

A. Yes.

Q. In general, what are your conclusions regarding the spill scenarios?

A. The spill scenarios do not include a long-term chronic leak scenario below the detection of the SCADA System. All five of the "long term" scenarios in the Product Spill Analysis are less than 14,000 gals spilled product. As discussed above, a spill of 1% of initial pipeline flow rate would result in a leak of 25,000 gallons in a single day.

Another critical component of the spill scenarios that is not addressed is the amount of oil that remains in the pipeline after the valves are closed and no more oil is flowing. Because much of the route has major gains in elevation (in contrast to the North-South Pipeline), it is possible that product in many miles of pipe could drain out following at leak.

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Little information is presented in the spill scenarios about groundwater penetration. All of the spills scenarios with groundwater impacts (Nos. 1, 2, 5 and 9) were detected quickly, which avoids analysis of potential impacts of the spill to groundwater. For example, a major chronic leak is not presented in any spill scenario where 100,000 gallons or more have penetrated below the trench soil before the spill was detected. Our groundwater risk model in Table 3, Exh. GAP-1, Tab C indicates that such large spills would present substantial potential for health risks due to groundwater contamination.

Scenario 5 of the Product Spill Analysis is a spill into the South Fork of the Snoqualmie River. The scenario can be used to demonstrate that more information on the impacts of the spill to fisheries resources should be generated in the Application. The extent of the impact of the spill to aquatic life in the scenario is indicated by the statement that "acute toxicity to aquatic life in the river occurs along with affects to vegetation and wildlife habitat." In the scenario, the flow in the river was gauged to be 210 cfs. This is within the bounds of the Alice Creek gauge north of Garcia WA (USGS Station No. 12143400), which shows a range of flows from below 100 cfs in July and August to well over 1,000 cfs in many of the winter months. Flows as high as 4,800 and 5,480 cfs have been recorded by USGS in fall and winter of 1995 and 1996, respectively.

Assuming that 20% of the product enters the creek (i.e., 4,000 gallons), that the 4,000 gallons enters over 10 hours at a river flow rate of 210 cfs, and assuming complete mixing and factoring in the density of the oil, the estimated concentration of refined product would be 53 parts per million (i.e., 53 mg/L). This concentration exceeds the acute toxicity threshold for fish presented. The analysis suggests that acute toxicity to fish could occur under Spill Scenario 5, and should be evaluated in more detail.

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Q. In summary, what is your opinion regarding Olympic's consideration of risks to surface and groundwater from exposure to refined petroleum products?

A. The lack of estimates of the aquatic ecological and health risks from exposures to toxic constituents of petroleum products that may leak or spill from the proposed Cross Cascade pipeline is a serious deficiency in OPL's Application. As shown above, methods are available to estimate such risks that can provide information about areas along the route that may require improved safety measures to minimize any risks. Quantitative estimates of potential impacts and ecological and health risks can also be used in the determination of costs of cleanup or mitigation, and to help determine whether certain alternatives which present lower risk should be preferred, even if they cost more to construct. These types of analyses were not explored in the Application.

The increased chance of spills in flood prone areas, seismically active areas, and steep slopes has also not been factored into an assessment of ecological or health risks. These increased risk factors should be considered in pipeline route planning. The risks associated with various alternative modes of product transport need to be compared in a quantitative fashion to make them more meaningful and to increase comparison accuracy and predictability. Without a comparable risk analysis of various alternatives, a cost comparison of the alternatives will be incomplete and inadequate.

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